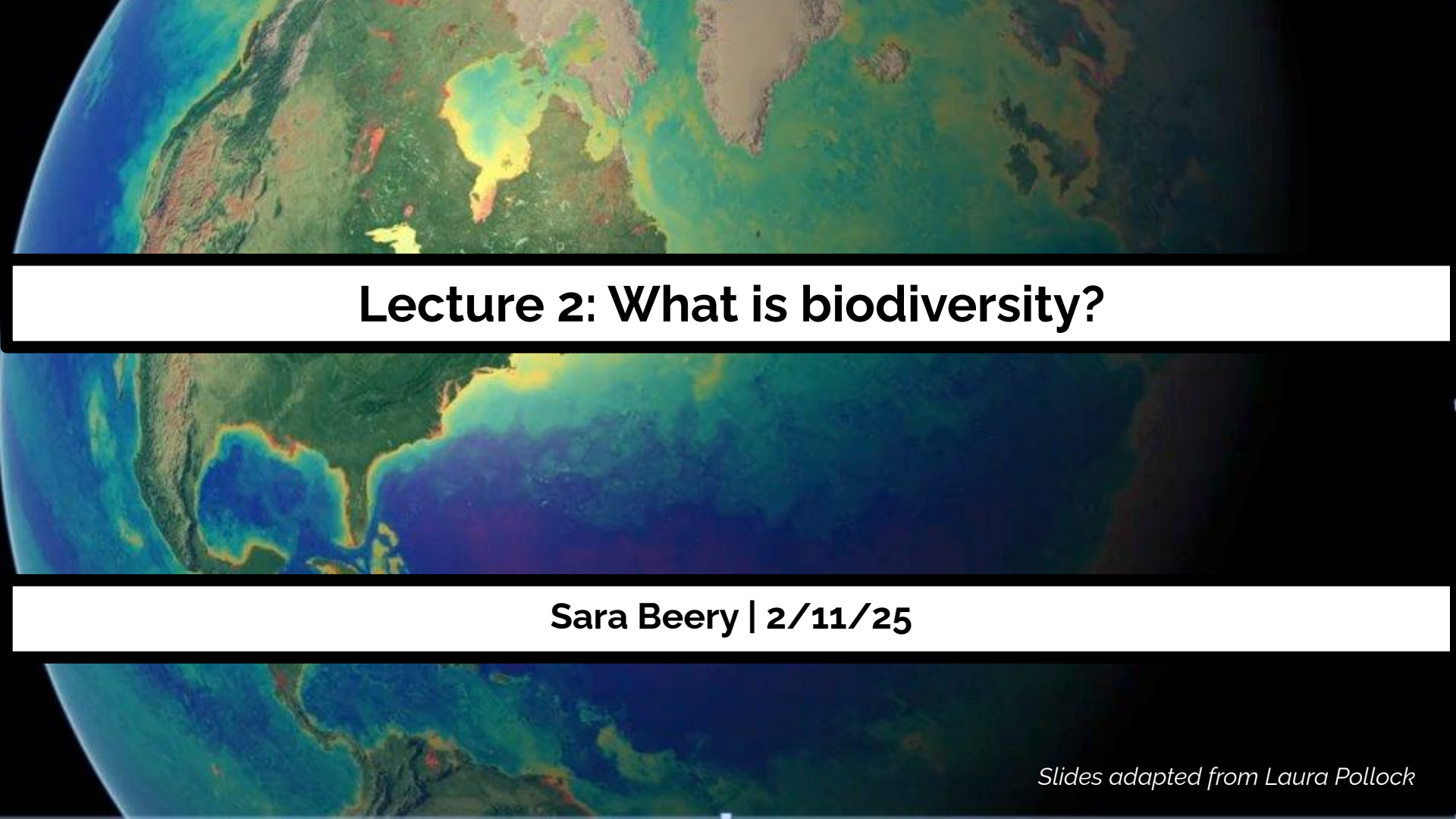
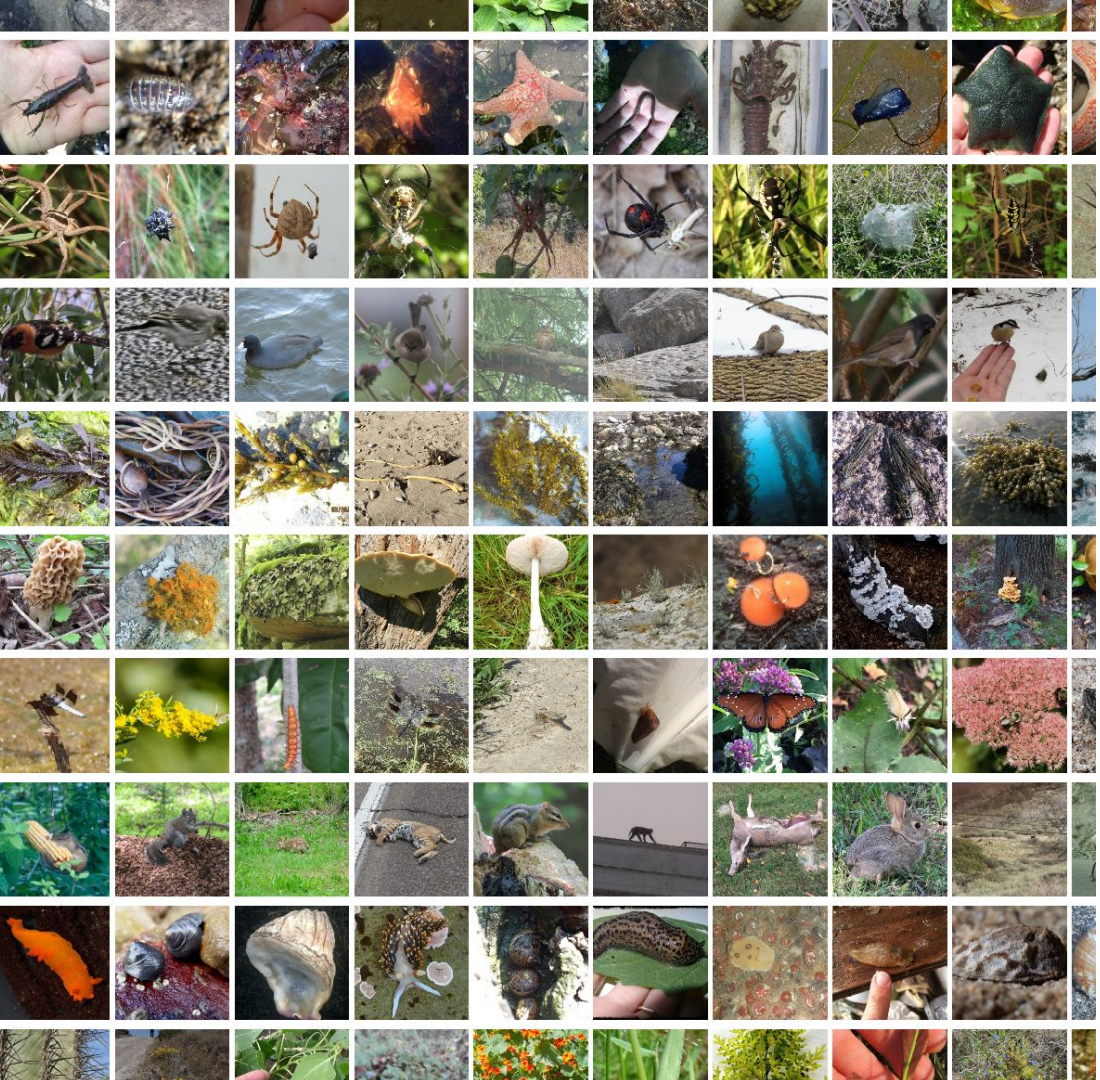


Lecture 2: What is biodiversity?

Sara Beery | 2/11/25

Slides adapted from Laura Pollock



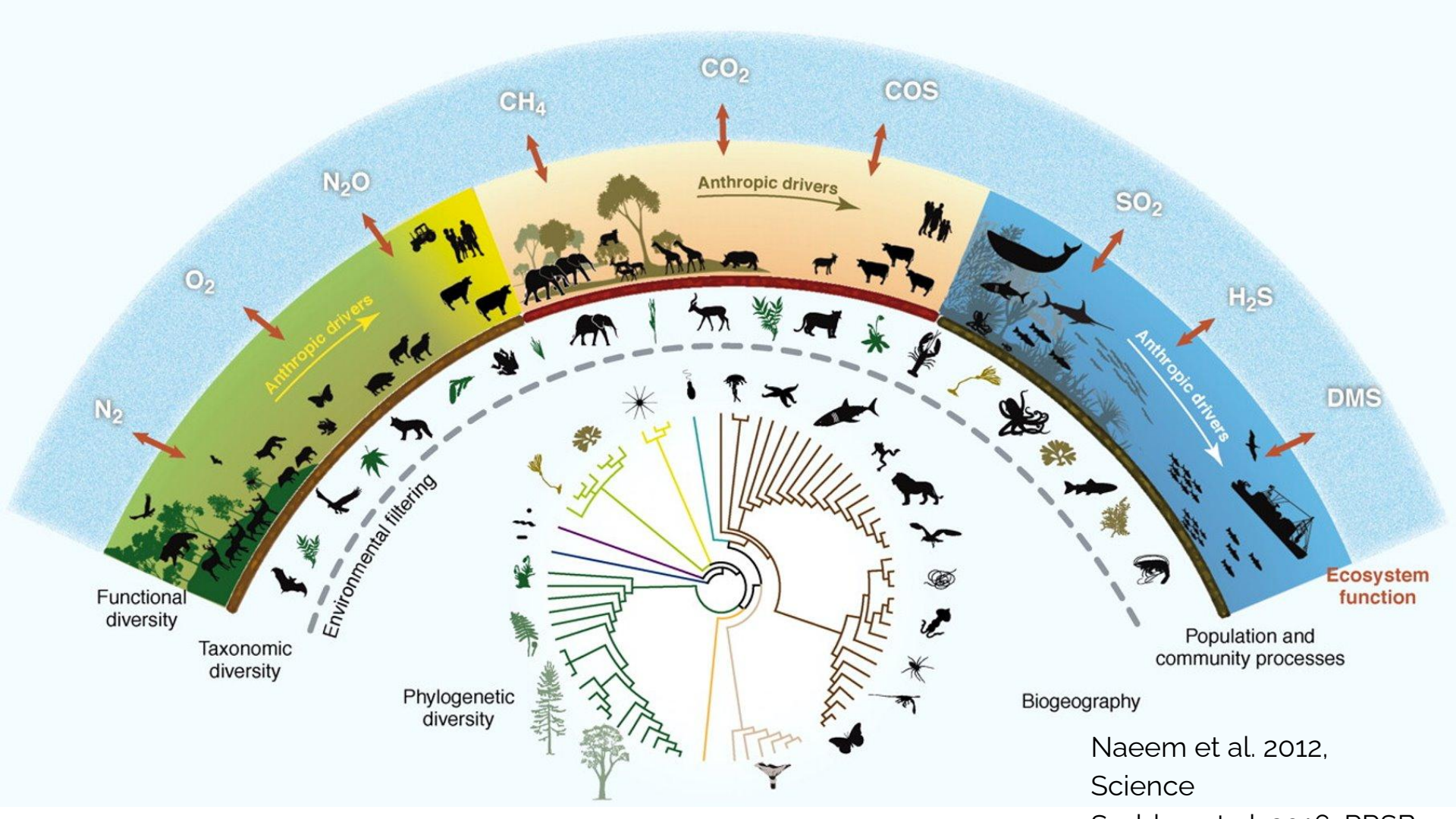
Biological diversity

Biodiversity: numbers of entities (genotypes, species, or ecosystems), their relative abundance, and the differences in their traits and interactions with other species.

Taxonomic diversity: *richness and abundance of species*

Phylogenetic diversity: *presence of different evolutionary lineages*

Functional diversity: *variety of growth forms and resource use strategies*



Naeem et al. 2012, Science

Biodiversity science is a multi-disciplinary field using tools and theories from different areas such as ecology, evolution, molecular biology, taxonomy, genetics, traditional ecological knowledge, political sciences, and economics.

- Understand how and why biodiversity changes in space over time.
- Predict biodiversity change in response to human drivers/impacts.
- Analyze how biodiversity change impacts ecosystem functioning and the many services/benefits human society receives from biologically diverse ecosystems.

History of “biodiversity”

1916 – The term biological diversity was used first by J. Arthur Harris in "The Variable Desert," Scientific American:
"*The bare statement that the region contains a flora rich in genera and species and of diverse geographic origin or affinity is entirely inadequate as a description of its real biological diversity.*"

1980 – Thomas Lovejoy introduced the term biological diversity to the scientific community in a book. It rapidly became commonly used.

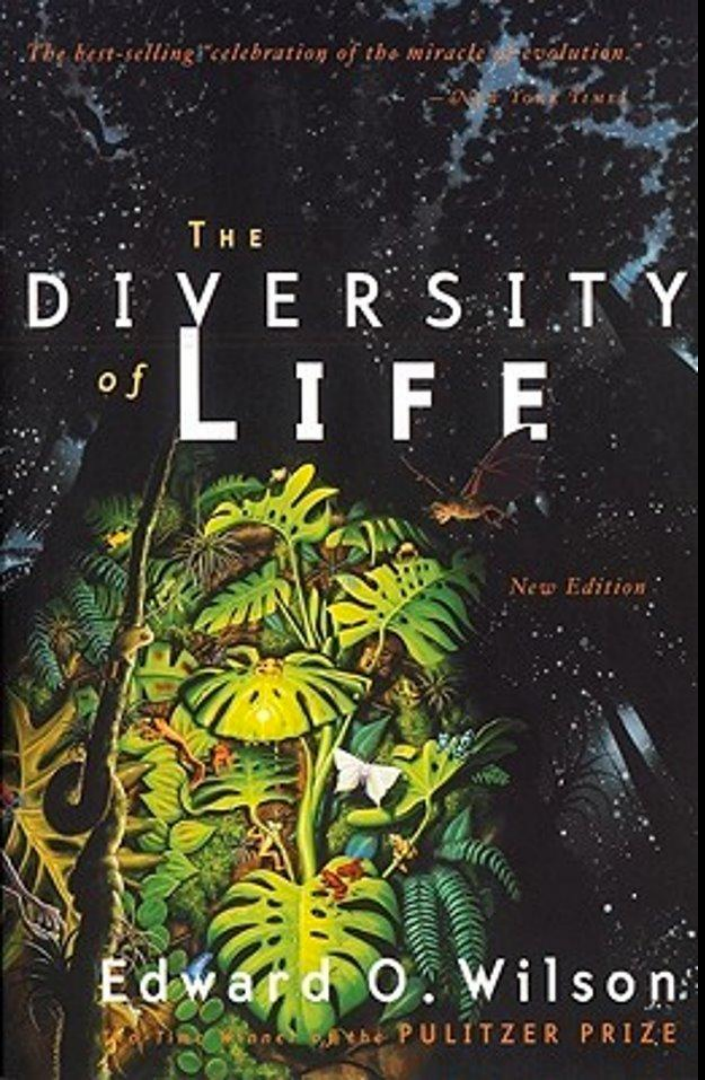
1985 – According to Edward O. Wilson, the contracted form biodiversity was coined by W. G. Rosen

1988 - The term biodiversity first appeared in a publication.

1992 - The 1992 United Nations Earth Summit defined "biological diversity” and established the treaty called Convention on Biological Diversity. www.cbd.int

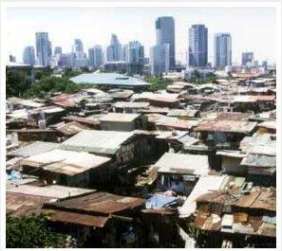
1992 – Edward O. Wilson published *The Diversity of Life* and the term becomes mainstream.

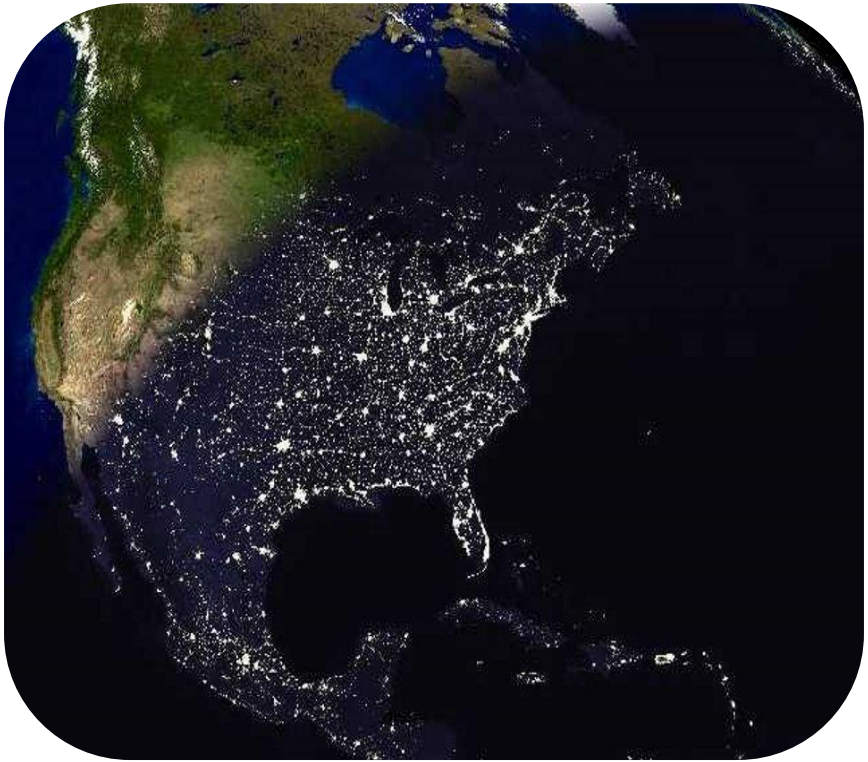
2012 - The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is formed: www.ipbes.net



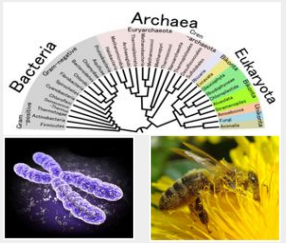
"Life in a local site struck down by a passing storm springs back quickly: opportunistic species rush in, to fill the spaces. They entrain the succession that circles back to something resembling the original state of the environment."

Society





Biosphere



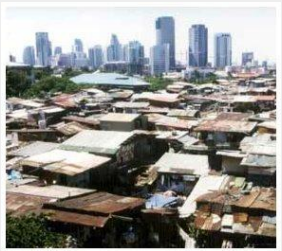
Biodiversity

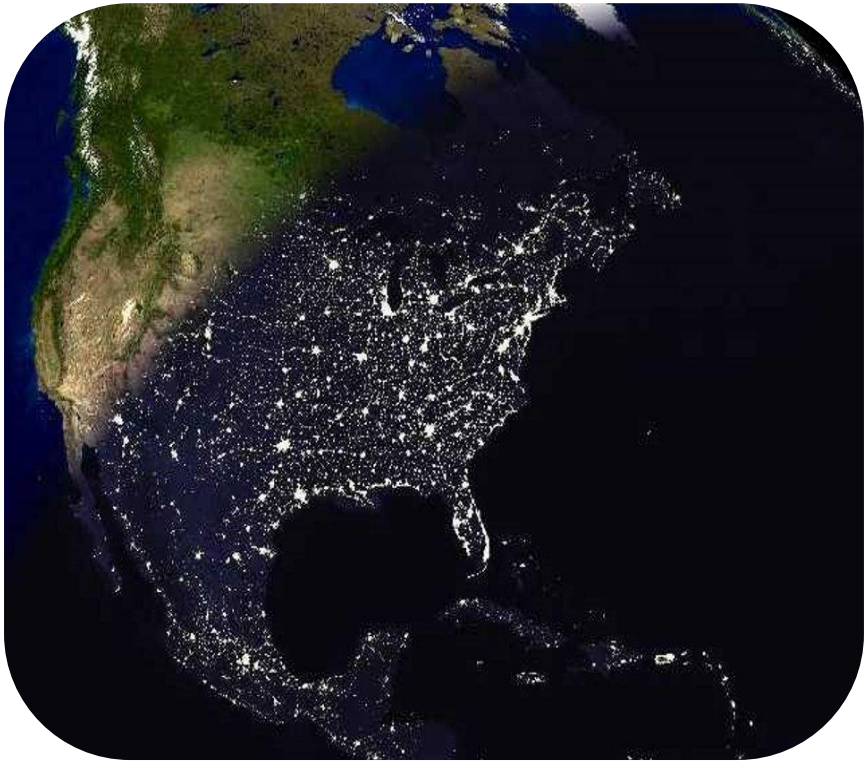
Ecosystem

Human activities

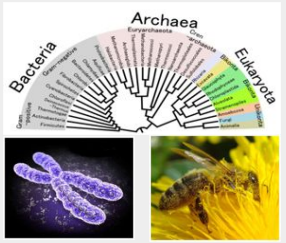
(land use, harvesting, extraction, pollution, restoration, protection)

Society





Biosphere



Biodiversity

Ecosystem

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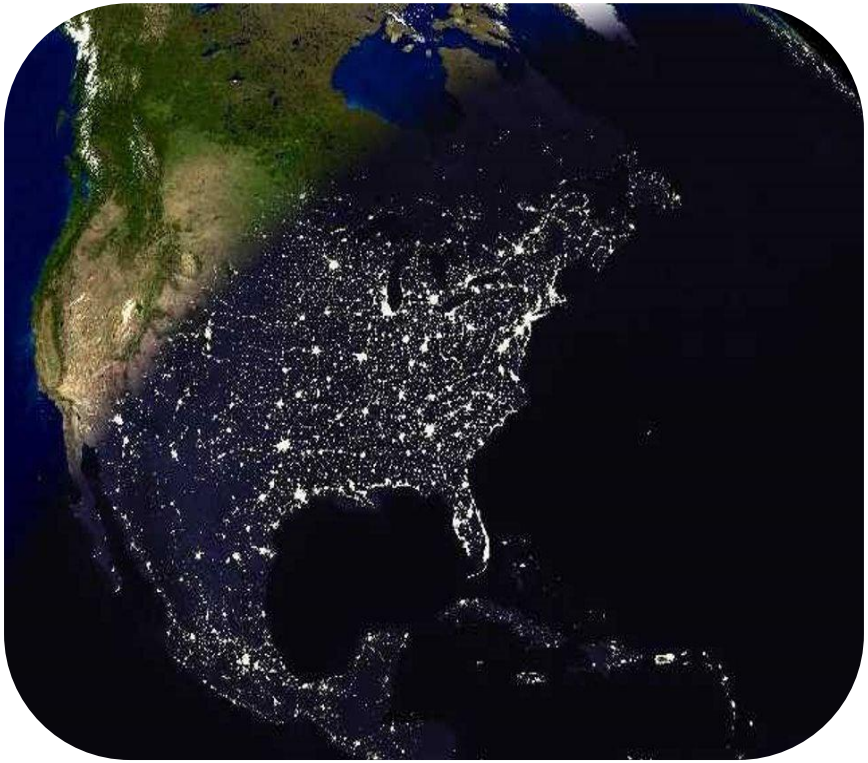
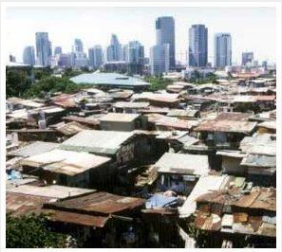
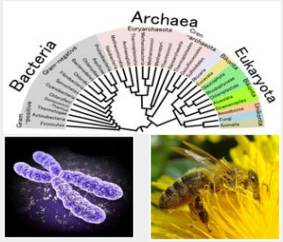


Society



Biosphere



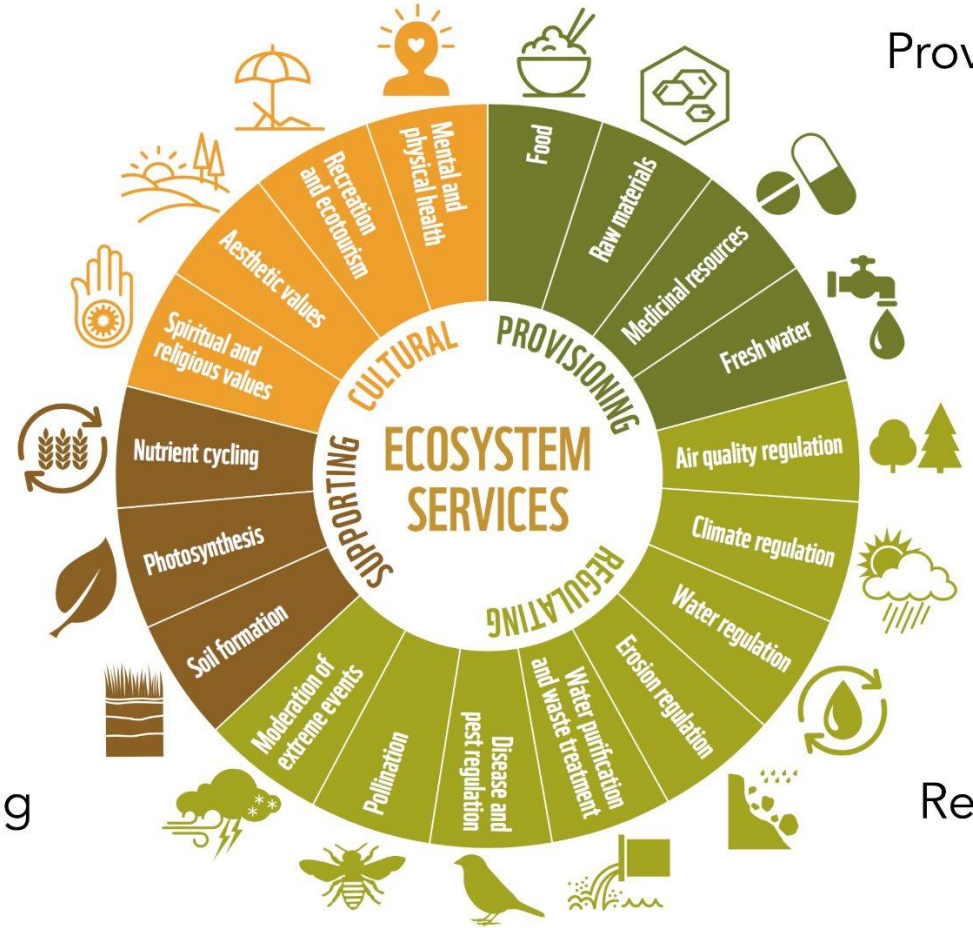
Biodiversity

Ecosystem

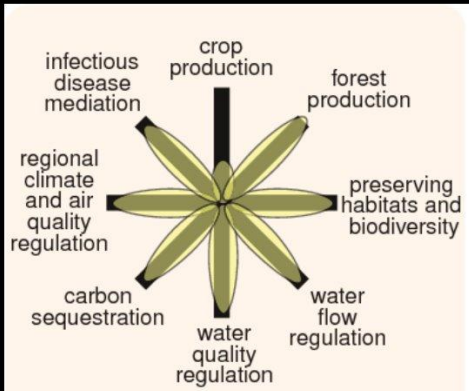
Benefits/impacts

(energy, material, food, water)

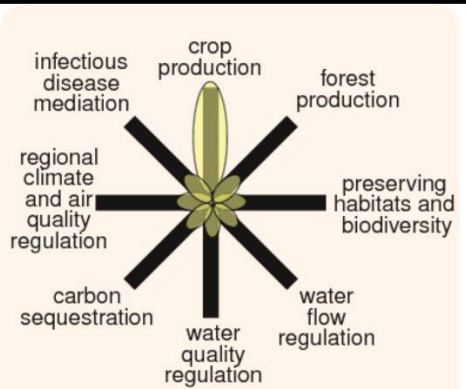
“Ecosystem services”



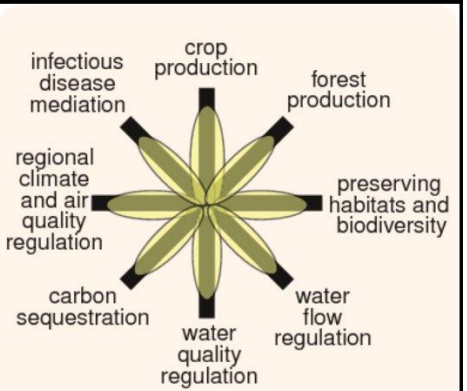
Ecosystem services in landscapes



natural ecosystem



intensive cropland



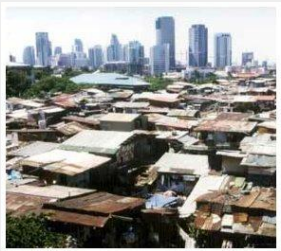
cropland with restored ecosystem services

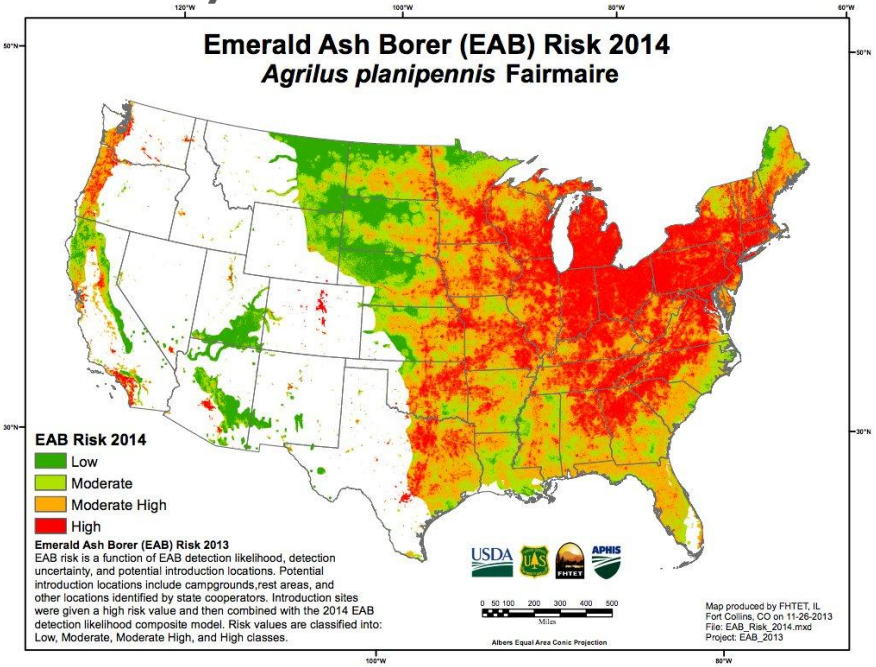
Foley et al. 2005 *Science*

Global Trade

8.7 billion Ash trees in US

Social System





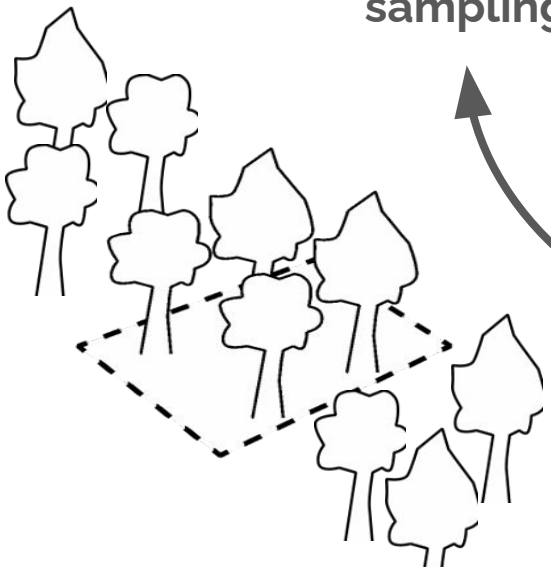
Emerald Ash Borer

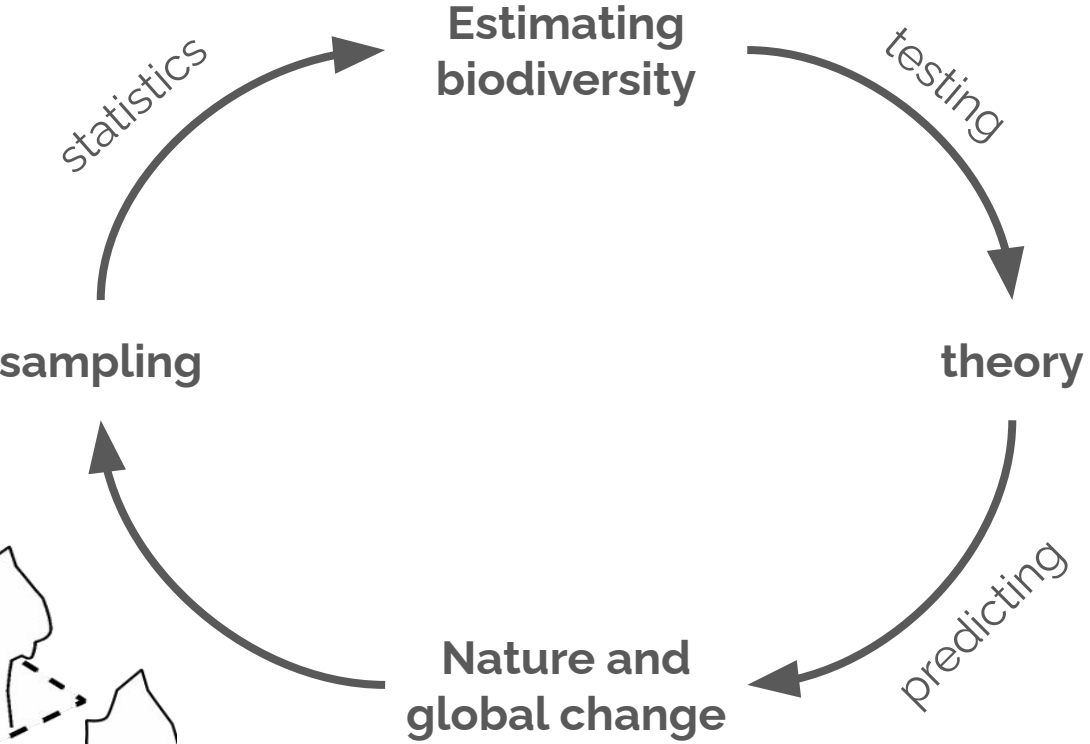
Fraxinus sp.

Ecological/economic costs

~11-25 Billion

Measuring biodiversity

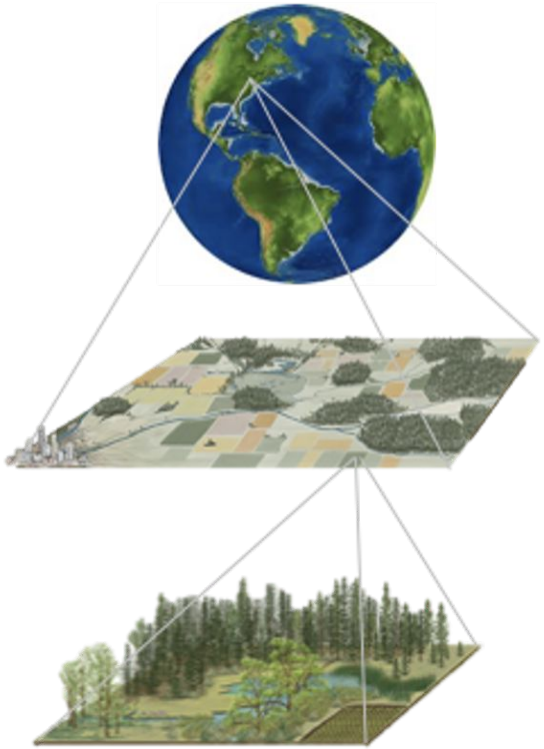




Understanding biodiversity

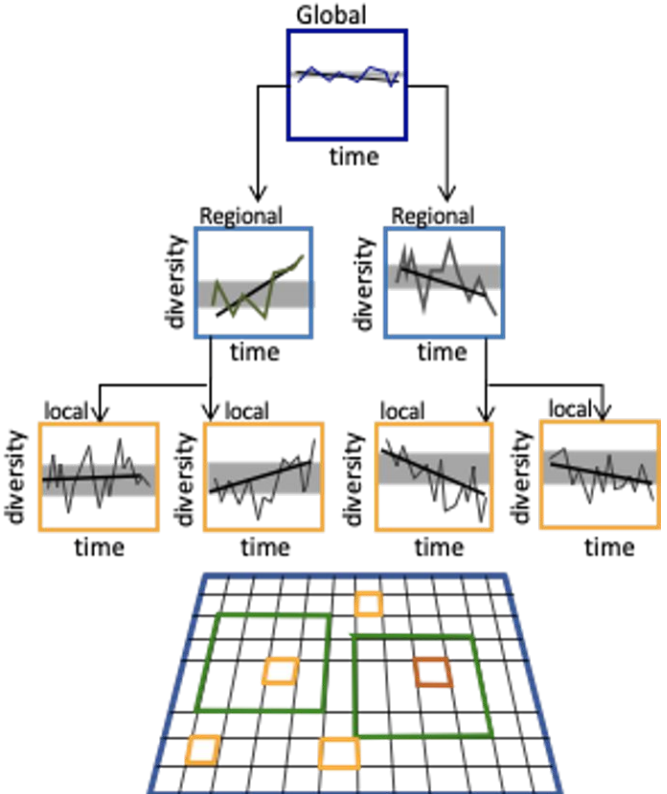
Measuring biodiversity change

Scale

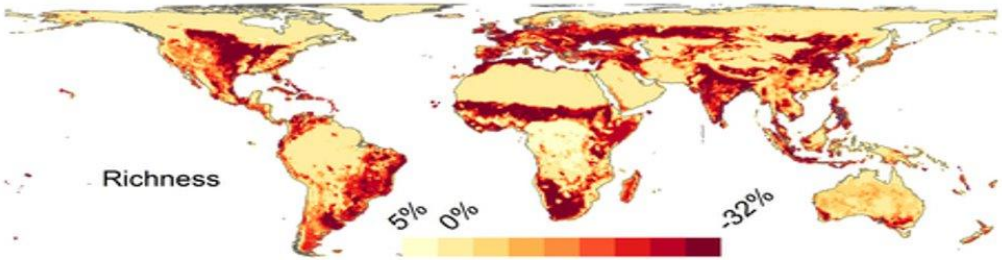


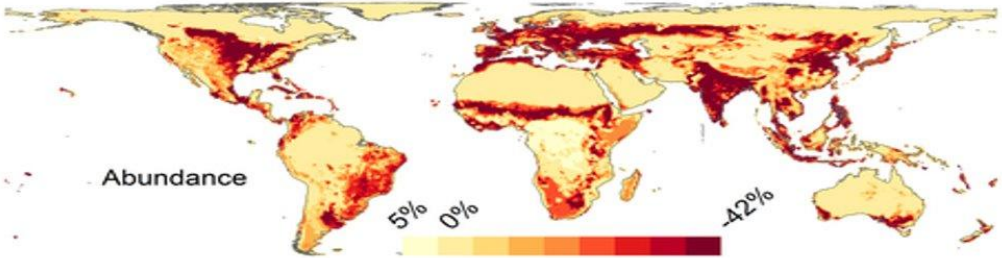
Drivers

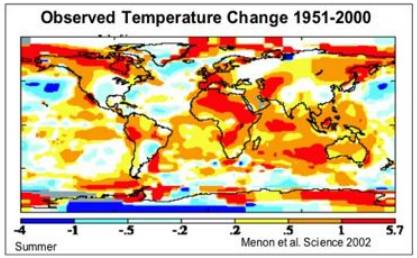
Trends and extremes



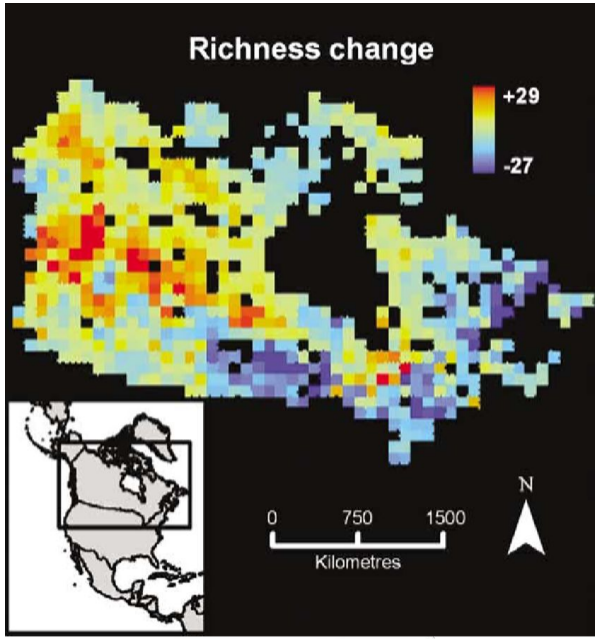
Biodiversity change is happening globally

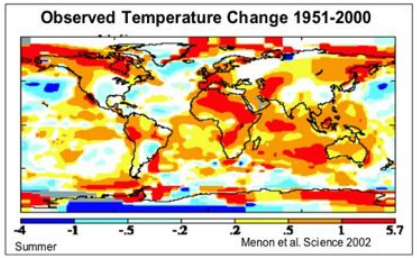






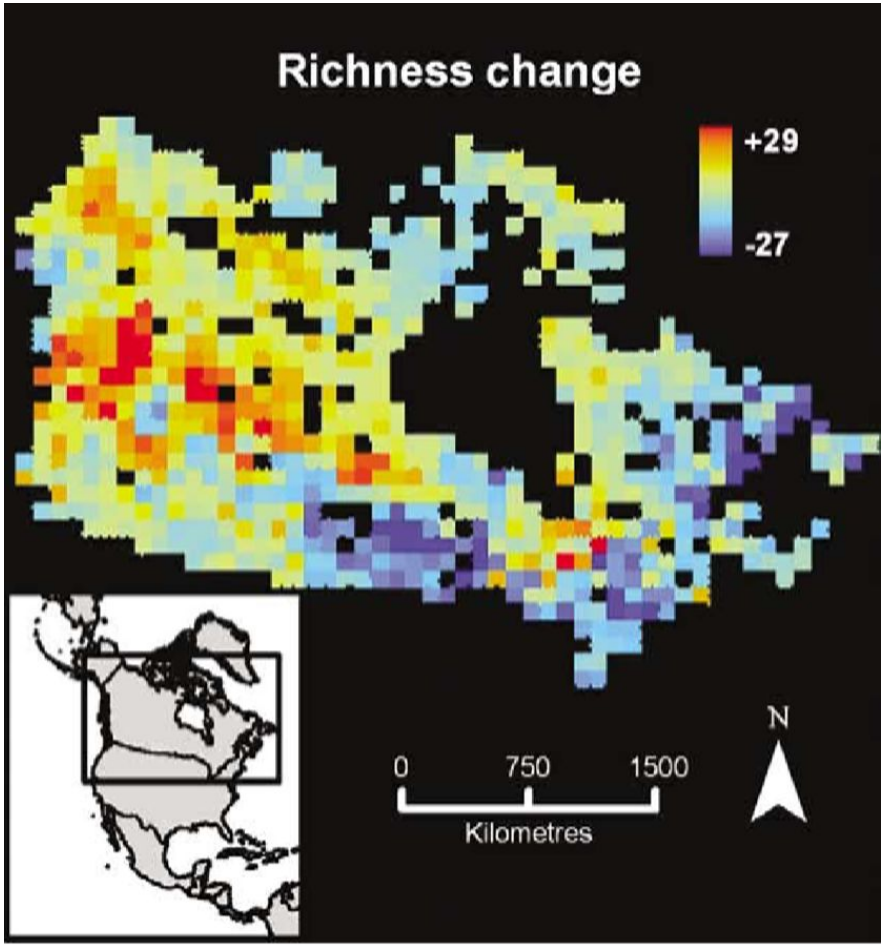
Biodiversity change is happening globally





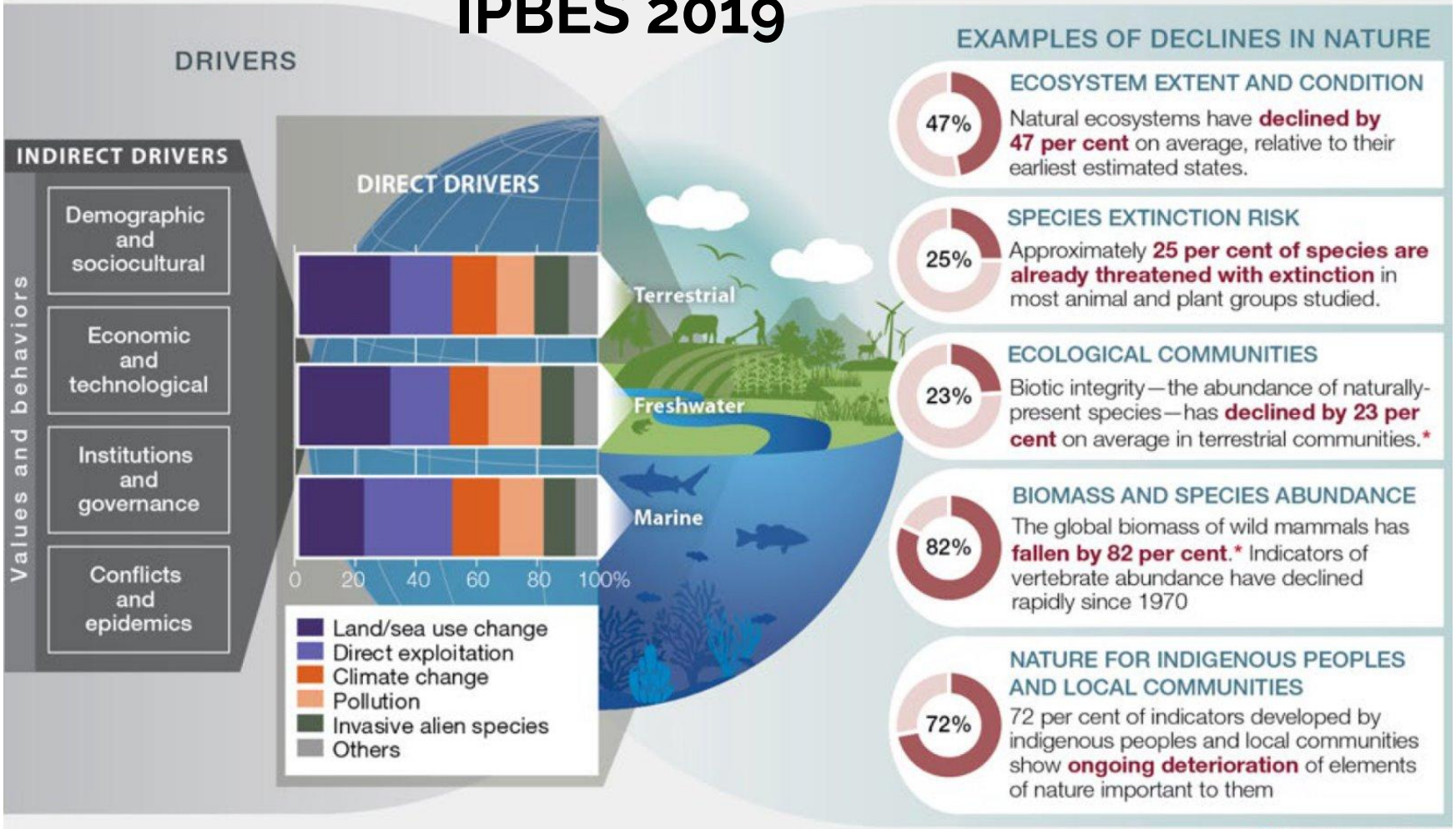
Algar et al (2009) *Ecography*

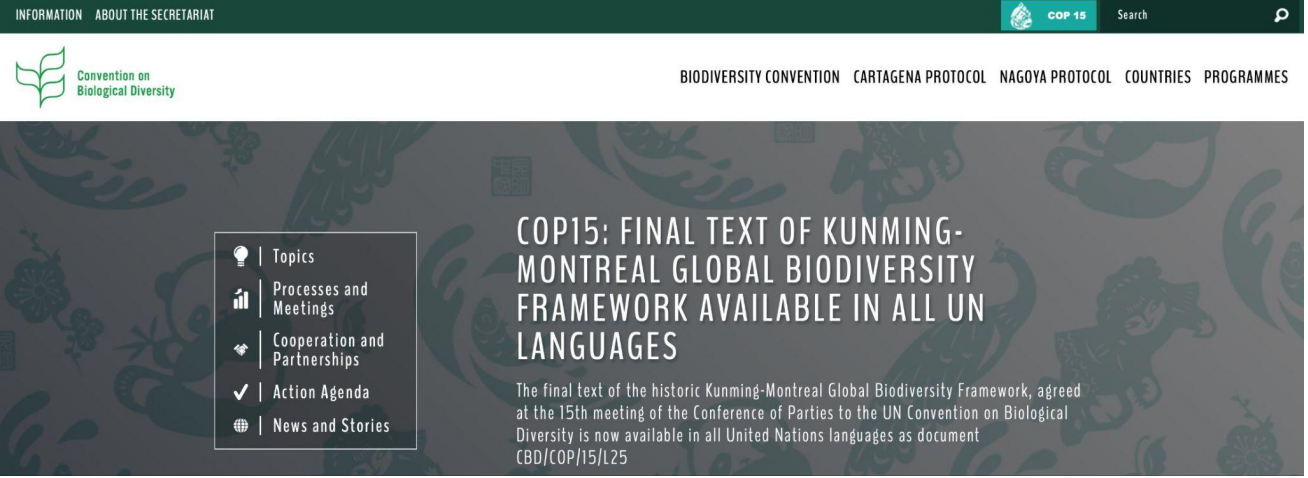
Biodiversity change is happening regionally



Algar et al (2009) *Ecography*

IPBES 2019


DRIVERS
INDIRECT DRIVERS
Values and behaviors
Demographic and sociocultural
Economic and technological
Institutions and governance
Conflicts and epidemics
DIRECT DRIVERS
Terrestrial
Freshwater
Marine
0
20
40
60
80
100%
Land/sea use change
Direct exploitation
Climate change
Pollution
Invasive alien species
Others
EXAMPLES OF DECLINES IN NATURE
47%
ECOSYSTEM EXTENT AND CONDITION
Natural ecosystems have declined by 47 per cent on average, relative to their earliest estimated states.
25%
SPECIES EXTINCTION RISK
Approximately 25 per cent of species are already threatened with extinction in most animal and plant groups studied.
23%
ECOLOGICAL COMMUNITIES
Biotic integrity—the abundance of naturally-present species—has declined by 23 per cent on average in terrestrial communities.*
82%
BIOMASS AND SPECIES ABUNDANCE
The global biomass of wild mammals has fallen by 82 per cent.* Indicators of vertebrate abundance have declined rapidly since 1970
72%
NATURE FOR INDIGENOUS PEOPLES AND LOCAL COMMUNITIES
72 per cent of indicators developed by indigenous peoples and local communities show ongoing deterioration of elements of nature important to them
* Since prehistory



Secretariat of the Convention on Biological Diversity (CBD)

Global Biodiversity Framework (GBF) negotiated in 2022

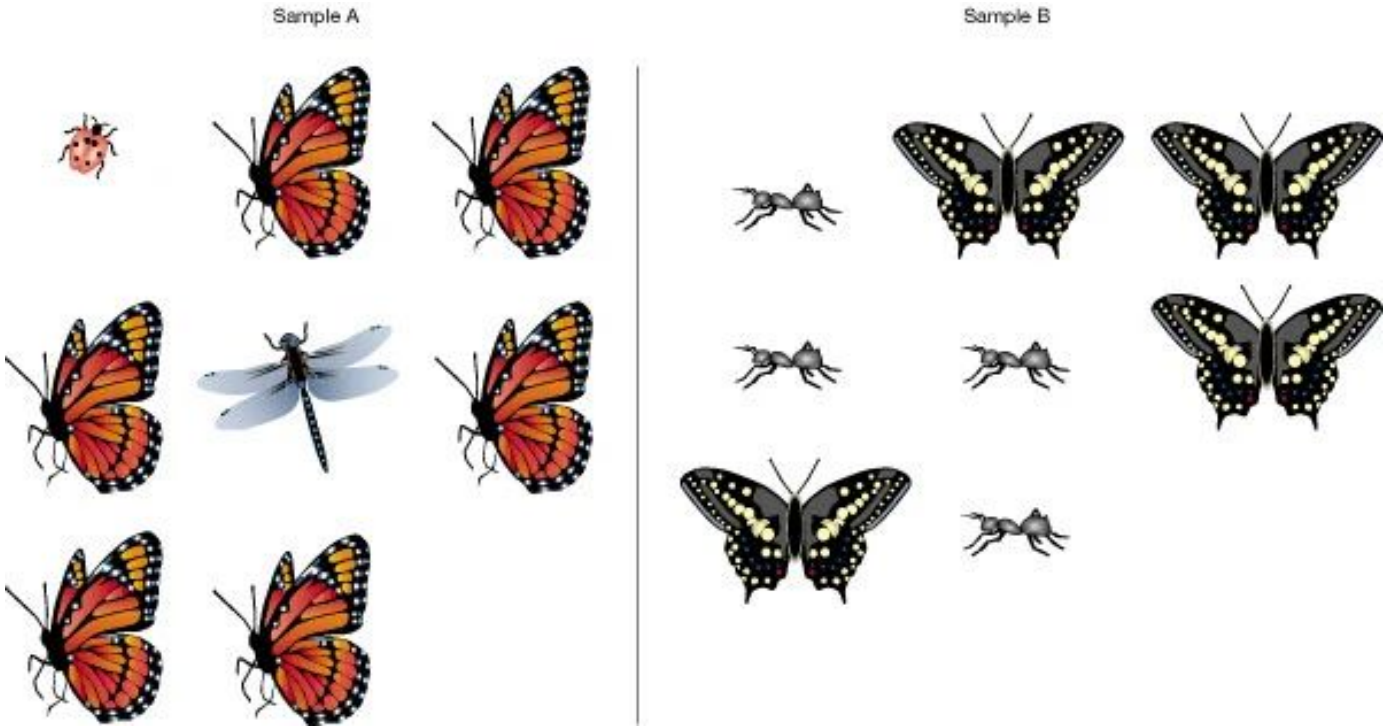
GOAL A

- The integrity, connectivity and resilience of all ecosystems are maintained,enhanced, or restored, substantially increasing the area of natural ecosystems by 2050;
- Human induced extinction of known threatened species is halted, and, by2050, extinction rate and risk of all species are reduced tenfold, and the abundance of native wild species is increased to healthy and resilient levels;
- The genetic diversity within populations of wild and domesticated species,is maintained, safeguarding their adaptive potential.

GOAL B

- Biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development, for the benefit of present and future generations by 2050.

But what do we actually measure?



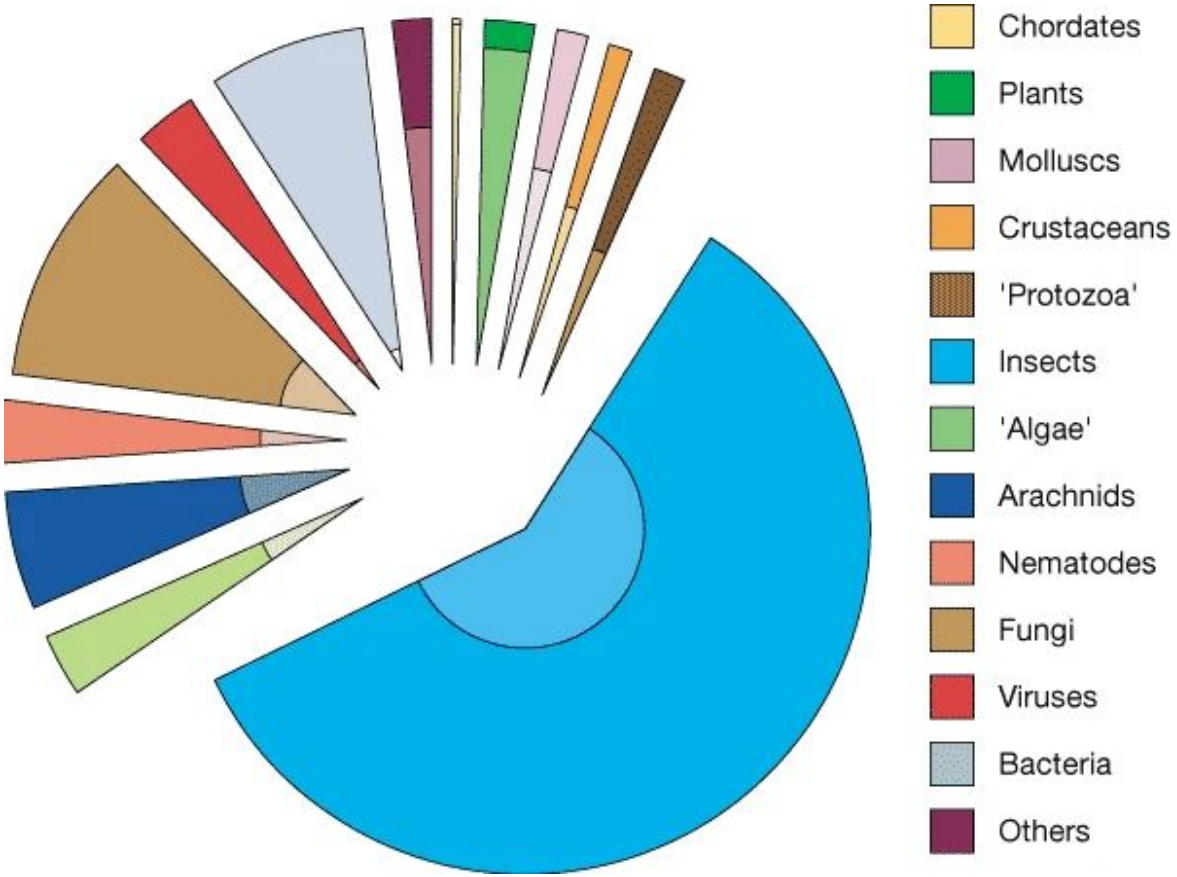
Sample A could be described as being the more diverse as it contains three species to sample B's two. But there is less chance in sample B than in sample A that two randomly chosen individuals will be of the same species.

https://www.nature.com/articles/35012221

Common biodiversity measurements

- Richness (how many species)
- Distribution
  - Habitat suitability
- Abundance
- Movement
  - Home range
  - Connectivity
- Demography
  - E.g. birth and death rates
- Trophic interaction
  - Biotic
  - Abiotic
- Phylogeny
- Phenology

Species richness



Pie is estimated number of species, inner pie is number that have been described

How do we know where things aren't?

What do we do with these measurements?

- Spatial prioritization
- Management of protected areas
- Adaptive conservation action
- Prevent spread of invasives/disease/pests
- Setting harvesting and permitting
- Regulating extractive industry
- Biodiversity finance?

Global Biodiversity Observation Network